Electronic Version
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Claims

[c1] What is claimed is:

1. A two-stroke engine comprising:
an engine having at least one cylinder and a piston reciprocally disposed therein, and a scavenging port for egress of exhaust gasses therefrom;
a charge purity detector in operable association with the at least one cylinder to detect irregular combustion in the at least one cylinder; and
an ECU connected to receive signals from the charge purity detector and programmed to adjust a charge parameter in a next cycle in response to a detected irregular combustion.

[c2] 2. The two-stroke engine of claim 1 wherein the next cycle is one of a different cylinder in a multi-cylinder engine, and a same cylinder in one of a multi-cylinder engine and a single cylinder engine.

[c3] 3. The two-stroke engine of claim 1 wherein the charge parameter is fuel quantity.

[c4] 4. The two-stroke engine of claim 1 wherein the ECU is further programmed to adjust fuel quantity in a next cy-

cle of the at least one cylinder having irregular combustion and another cylinder.

[c5] 5. The two-stroke engine of claim 1 wherein the charge purity detector is at least one of:
an ionization detector;
a crankshaft velocity variation detector; and
an exhaust gas temperature sensor.

[c6] 6. The two-stroke engine of claim 5 wherein the charge purity detector is a combination of:
an ionization detector;
a crankshaft velocity variation detector; and
an exhaust gas temperature sensor.

[c7] 7. The two-stroke engine of claim 5 wherein the ionization detector includes a pair of electrodes positioned in a respective cylinder to monitor ionization in the respective cylinder and wherein the ECU is programmed to associate irregular combustion with a given level of ionization in the respective cylinder.

[c8] 8. The two-stroke engine of claim 5 wherein the crankshaft velocity variation detector monitors crankshaft rotation and the ECU is programmed to associate a misfire of a respective cylinder with a detected variation in a crankshaft velocity.

[c9] 9. The two-stroke engine of claim 5 wherein the exhaust gas temperature sensor monitors exhaust gas from a respective cylinder, and the ECU determines an exhaust gas temperature therefrom and determines combustion conditions from the exhaust gas temperature of the respective cylinder.

[c10] 10. The two-stroke engine of claim 1 wherein the ECU is programmed to adjust fuel rate of a next charge in response to oxygen content of a previous charge.

[c11] 11. The two-stroke engine of claim 10 wherein the ECU is programmed to provide more fuel in the next charge if the oxygen content in the previous charge is higher than expected, and provides less fuel in the next charge if the oxygen content in the previous charge is lower than expected.

[c12] 12. The two-stroke engine of claim 1 wherein the engine comprises at least two cylinders having respective scavenging ports connected together at a common exhaust system, wherein the common exhaust system is tuned such that exhaust from one cylinder plugs a scavenging port and restricts egress of a fresh charge out the scavenging port, and wherein the ECU is programmed to adjust fuel quantity to a cylinder based on a predicted

amount of scavenging port plug from a previous cycle.

[c13] 13. The two-stroke engine of claim 7 wherein the ECU is further programmed to provide more fuel in the next cycle if the given level of ionization in the respective cylinder is indicative of slow combustion and provide less fuel in the next charge if the given level of ionization is indicative of a misfire.

[c14] 14. The two-stroke engine of claim 7 wherein the ECU is further programmed to induce a temporary constant voltage across the pair of electrodes to detect the given level of ionization in the respective cylinder and monitor a current therebetween.

[c15] 15. The two-stroke engine of claim 7 wherein the pair of electrodes is a spark plug.

[c16] 16. The two-stroke engine of claim 7 wherein the pair of electrodes is an auxiliary pair of electrodes.

[c17] 17. The two-stroke engine of claim 1 incorporated into one of a watercraft, an all-terrain vehicle, a motorcycle, a scooter, a snowmobile, and a lawn equipment.

[c18] 18. A method of controlling fuel injection within a combustion engine, the method comprising:
receiving an electronic signal indicative of combustion

thoroughness in at least one cylinder of an engine;
determining from the electronic signal whether the combustion in the at least one cylinder was regular or irregular; and
if irregular, adjusting an operating parameter for a next combustion to compensate for irregular combustion.

[c19] 19. The method of claim 18 further comprising adjusting an amount of fuel delivered into at least one of the at least one cylinder or another cylinder.

[c20] 20. The method of claim 18 further comprising decreasing an amount of fuel delivered if the determined irregular combustion is less than an ideal charge purity and increasing an amount of fuel injected into the at least one cylinder if the determined irregular combustion is greater than the ideal charge purity.

[c21] 21. The method of claim 18 wherein adjusting the operating parameters further comprises adjusting an amount of fuel injected in a next combustion cycle.

[c22] 22. The method of claim 18 further comprising:
monitoring conductivity in a combustion chamber;
monitoring a crankshaft velocity; and
monitoring an exhaust gas temperature.

[c23] 23. The method of claim 22 wherein the monitoring con-

ductivity further comprises detecting a given level of ionization in the combustion chamber.

[c24] 24. The method of claim 22 wherein the monitoring crankshaft velocity further comprises detecting a variation in crankshaft velocity.

[c25] 25. The method of claim 22 wherein the monitoring exhaust gas temperature further comprises detecting a variation in exhaust gas temperature.

[c26] 26. The method of claim 18 further comprising predicting an increase in charge purity if the indicia of irregular combustion is indicative of slow combustion in the at least one cylinder and increasing fuel quantity in a next cycle.

[c27] 27. The method of claim 18 further comprising predicting a decrease in charge purity if the indicia of irregular combustion is indicative of a misfire in the at least one cylinder and decreasing fuel quantity in a next cycle.

[c28] 28. An outboard motor comprising:
a powerhead having a combustion engine, a midsection configured for mounting the outboard motor to a watercraft, and a lower unit powered by the engine to propel a watercraft;
at least one combustion condition monitor to monitor at

least one cylinder of the combustion engine; and

an ECU to receive feedback from the combustion condition monitor and configured to adjust an operating parameter in a next combustion cycle if the feedback from the combustion condition monitor is indicative of atypical combustion.

[c29] 29. The outboard motor of claim 28 wherein the charge combustion condition monitor is configured to determine an oxygen concentration in the at least one cylinder during the next combustion cycle.

[c30] 30. The outboard motor of claim 29 wherein the ECU is configured to deliver an over-fueling quantity of fuel in the next combustion cycle if the oxygen concentration in the next combustion cycle is higher than expected.

[c31] 31. The outboard motor of claim 29 wherein the ECU is configured to deliver an under-fueling quantity of fuel in the next combustion cycle if the oxygen concentration in the next combustion cycle is lower than expected.

[c32] 32. The outboard motor of claim 28 wherein the atypical combustion is detected by monitoring at least one of a conductivity within the at least one cylinder, a variation in crankshaft velocity, and a variation in exhaust gas temperature.

[c33] 33. The outboard motor of claim 28 wherein the operating parameter adjusted is a fuel quantity of the at least one cylinder.

[c34] 34. The outboard motor of claim 28 wherein the operating parameter adjusted is a fuel quantity of another cylinder of the combustion engine.

[c35] 35. A engine control unit configured to:
receive a combustion signal indicative of a combustion condition within at least one cylinder of a combustion engine;
compare the combustion signal to a desired combustion parameter; and
if outside a given range, adjust at least one operating parameter during a next combustion cycle.

[c36] 36. The engine control unit of claim 35 wherein the operating parameter includes a fuel injection parameter and the next combustion cycle is of at least one of the at least one cylinder and another cylinder.

[c37] 37. The engine control unit of claim 35 wherein the combustion signal includes an induced current level indicative of ionization within the at least one cylinder during a current combustion cycle.

[c38] 38. The engine control unit of claim 37 further configured to increase an quantity of fuel delivered into the at least one cylinder if the induced current level is indicative of slow combustion and decrease the quantity of fuel delivered to the at least one cylinder if the induced current level is indicative of a misfire.

[c39] 39. The engine control unit of claim 35 wherein the combustion signal is at least one of a variation in ionization in the at least one cylinder, a variation in crankshaft velocity, and a variation in exhaust gas temperature leaving the at least one cylinder.

[c40] 40. A system for adjusting a fuel quantity delivered to a combustion chamber of an engine comprising:
means for determining a charge purity within a combustion chamber; and
means for adjusting a quantity of fuel delivered during a next combustion cycle according to the charge purity.